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## PERCEPTION AND NATURE

FORMERLY the philosopher's example was the table. One observer viewed it from one angle, another from a different, both at rest relatively, but in different axis systems. The inevitable question, "What is the real table?" followed. There is, of course, an assumption here, namely, that there is a real table, which we shall touch later. As a result of the extension of points of view, such, for example, as those made possible by the reduction of three-fold kinematics to four-fold statics, and dynamics to four dimensional geometry; and because of the "isolation of the epistemological problem," the question of perception and its relation to nature and to natural knowledge is forcibly brought to our attention.

Again, the foundations of geometry were investigated during the nineteenth century from the assumption of points as ultimate given entities in an absolute space. On such assumptions there is nothing more to be done in that field of research. However, on the assumption of relative space or of different space systems an investigation of the foundations of geometry will have to show how space and kinds of space originate from the relations of things given in perception, and what points are. "Thus the starting point for a discussion of the foundations of geometry is a discussion of the immediate data of perception."<sup>1</sup>

<sup>1</sup> Whitehead, A. N., *An Enquiry Concerning the Principles of Natural Knowledge*, p. 5.

The physicist has worked on the assumption that an explanation is complete when his subject matter is described in terms of mass, length, and time. His ultimate fact of nature was a distribution of matter in space at an instant of no duration. Such a conception of the ultimate nature of things is unable to account for such facts as momentum and velocity, which are matters of perceptual experience; nor can it account for any other natural facts which involve a space-time process. Processes are inexplicable on such assumptions and processes are facts of perceptual experience. Perception, therefore, becomes a central theme in the physical sciences and in mathematics, especially geometry.

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Science takes its origin very late in the experience of the race, and the foundations of it come to the attention of the individual late in his experience if ever at all. Since this is the case science—the physical sciences are meant—begins with a world of objects partially defined. It does not inquire into the origin of objects as such so long as the purely scientific attitude is maintained, but the aim is to give an adequate description of things that are. What is an “adequate” description is not our purpose here to inquire. What we shall attempt to do is to offer an outline of a theory of perception that is adequate to the physical sciences.

To make a start at all is an assumption, but one must be made somewhere. Our start is with processes. This is not the starting point of the physicist who begins with fixity, i. e., matter spread out in absolute space at a durationless instant, and who is unable, therefore, to account for what is perceived. It occurs to me that, taking what is perceived, namely, processes, as fundamental, it might be shown how what we call “elements” in the process and

the relations that obtain between them are generated from other and earlier processes. For example, it may be that what we speak of as space and time are elements (not simple) that come to be as the result of processes—that space and time, in a significant sense, are ways of description in nature rather than nature as something in space and time to be described. Indeed, it may be that the “I” of perception and the “object” of perception are elements that have been generated from earlier processes. Still further, it is possible that perception is itself a process fundamentally. We shall investigate that view of it.

Before we consider perception as a process it is well to consider processes in general of which perception is a subclass. The following characteristics (or possibly postulates would be better) are fundamental in all processes; (a) All processes may be described in terms of the same kind of terms; (b) All processes involve relata and relations; (c) There is no “simple” process; (d) One process extends over another. We shall discuss each of these briefly.

By (a) is meant that the language of description is the same for all classes of processes. For example, the grammar for so-called mental processes is no different from that which prevails in the description of physical processes. There is no peculiar method which is uniquely applicable to any one field of discourse to the exclusion of all others, but in any description of any process the same method is applicable. Suppose we are making a map of any process. Now such a map is, in the nature of the case, static, fixed, determined, and represents in one aspect a cross-section of the process, or, what the physicist would say, the process at an instant. If the map is complete it represents not only the process at an instant, but the possibility of the process at any instant. At any stage of the process now going on, past, or to come, there will be dis-

played terms and their relations adequate to the process. Such a map can be constructed for all processes, and the method for constructing them is the same for all.<sup>2</sup>

(b) It is a description of processes as *relata* and *relations* that renders the description adequate. We can not here attempt a discussion of these phenomena but wish only to indicate the sense in which they are employed. Suppose we wish to indicate the position of a point in a plane. By a convenient fiction, such as a system of Cartesian coördinates, this can be done, and we may say that the point is defined by the pair of equations  $5x - 4y = 0$ , and  $3x - 6y = 0$ . In such examples it will be seen that the point is itself the cross-section of relations. There is a significant sense in which objects may be defined in terms of relational cross-sections, or, what is more nearly correct, objects *are* such cross-sections. Of the kinds of relations and of the notion of similarity between them we have no intention to discuss, but *assuming* them, we may be certain that a description is adequate when relations and their cross-sections are displayed.

(c) There is no unique process or unit operation in terms of which all others can be described. We may, of course, discuss the dynamics of a particle, and then of a system of particles, using our former discussion as a foundation for the latter; or we may take uniform and multi-form functions in the same manner; or we may take sensory processes as "simples" in psychology and on them build up higher cognitive processes. Any process may be considered simple, but on further investigation it yields its con-

<sup>2</sup> This statement may appear too general. There are cases in which it will not hold provided certain almost unconscious and most "natural" assumptions are made. Since a map involves spatial connotations, it is easy to see that such a map could not be made for many processes. On the assumption of Euclidean space, for example, it is not possible to interpret certain arithmetical facts. It should be recognized that many of our "unsolvable" problems are such because of the assumptions which lie behind the statement of them. When we say a problem cannot be solved we mean that on the assumptions and with the method at our disposal a solution can not be made.

stituents. Simplicity is largely a matter of the purposes of the investigator.

If there were a unit process all phenomena, all the furniture of earth, heaven, and hell could be derived from it, given a sufficient technique. The universe would then be a universe; but in the present state of nature there are many unit processes which means there is no simple process. How these various unit processes are inter-related is one of the leading problems of philosophy; how they are discovered and the principle or principles upon which they are divided is the business of logic; and once the divisions are made (if it can be done) the investigator has the task of exploiting the subject matter of his field.

It may be impossible for logic to accomplish such a task as the one here suggested. It is certain that such a division as that proposed by John Stuart Mill, for example, leads to confusion. It may be that such a logical process of division and especially the search for principles of division involve circles; but circles do not seem as formidable as they once did. If all reasoning is circular, except as we define it otherwise, which can be done by taking a few terms as undefined and a few propositions as primitive, it is a weak charge against a bit of reasoning to assert it to be circular.

If all processes can be described in terms of the same kind of terms, does it not follow that there is a "simple" process? It is a cheap answer to say that the description of a process is not the process described. This may be true in some cases, but if the description is adequate there is a similarity between the two. There are cases, however, in which the description is the process, and the relation of similarity is then said to be "complete." Description is a technique, and what is meant by the statement that all processes may be described in terms of the same kind of terms is that the same technique is applicable to different

processes and not that since the technique is the same all processes may, therefore, be reducible to one simple process. Man is in possession of a method, more or less effective, for dealing with his world and this method is description (used in a wide sense). Description takes forms, is less accurate in some fields than in others, but in all fields the aim is the same, namely, to describe the facts of perception.

(d) The characteristic of processes by virtue of which they extend over each other is closely connected with that discussed in (c). The expression "extending over" is somewhat figurative, suggesting space and time, but these systems of order should be avoided at this point. They appear later as a resultant of the perceptual fact that one process extends over another, but our methods of description suggest the opposite view. It is this latter view that characterizes Newtonian mechanics, giving origin to absolute time which flows evenly on, and to the Kantian doctrine of the *a priori* nature of space and time. The notion that processes are the fundamental fact of nature demands that space and time be derived from them.

If processes are fundamental it would be strange if perception should be something else. It is not at all strange to believe that processes are given in perception, but it is not ordinary by any means to treat perception itself as another process. But a belief in the fundamentality of processes renders it difficult logically to stop short of this position. I am not saying that there are not certain invariants in processes, but perception certainly is not one of them.

The usual method of stating the problems of perception is such as to bring to the front the knower and the known, and the concomitant problem of primary and secondary qualities. A theory of perception which relegates a part of the world to mind and another part to nature fails,

it seems to me, to make any advance towards the solution of problems that have been in the philosophic atmosphere from the time of Descartes and Locke to our own time. Primary and secondary qualities are in the same boat. I believe the problem of perceptual errors and illusions, and the questions of primary and secondary qualities have been stated, and solutions of them given, in terms of a preconception of the relation between a knower and the known, *i. e.*, from a false emphasis on one or the other of the elements (or functions) in the perceptual process, issuing in answers analogous to that given to such a question as, "Why does a ball dropped from the front of a moving train reach the ground nearer the rear end of the train?"

It is true that the prevailing conceptions in any field determine the problems that can be solved as well as the method in which the problems are stated. If, for example, space is Euclidean is true, then the problems that can be stated and solved are predetermined; if imaginary numbers are not numbers is true, then it is useless to attempt a geometrical representation of the same; if disease is a matter of the possession of devils is true, medical technique is predetermined; if there is ether with certain characteristics, then the Fitzgerald equations have a place in nature. It seems that the statement of the perceptual problem and the solutions offered are no exceptions to this tendency.

Let us begin with perception as a process. By this is not meant what is commonly thought of as, "what is going on in the head." What is meant is that there is an event in nature which may be characterized as perceptual in the same way as when we speak of another event as political, or physical, or social.

There are at least three factors that enter into the determination of the kinds of process, namely, the terms, the resultant of the operations in the process, and the relations that obtain therein. It will be observed that terms



and relations are together. That is, terms imply relations and relations imply terms. It is possible, as suggested above, to reduce terms to the language of relations, but when this is done a relation is substituted for the original one, but the substituted one wears the garb of relations. We must possess these "solid" aspects of experience regardless of the garb they mask in.

It may appear that the whole "process" theory begs the question when it is asserted that the kind of objects (terms) which enter the process determine in part the kind of process. What is desired, it will be said, is a statement of processes which will determine the kind of object, and not, in advance, so to speak, a known kind of object which determines in part the kind of process. The difficulty in setting up such a statement is that in any reasoning process something is assumed, and all that can be expected of any theory is that it will find a place ultimately for the assumptions, *i. e.*, that they *yield*, as well as for the "facts" which it attempts to describe. It can be shown that objects actually are generated out of processes, but to describe the original process adequately requires the use of the very objects which issue from the process in question. Negative and imaginary numbers, for example, have been born out of operations on the fundamental operation of pure mathematics, namely, addition; but to describe adequately the operation of addition involves such a statement as would bring to light negative and imaginary numbers. No statement of the nature of addition is complete which does not make possible all the objects which may be generated out of it, and to render such a statement possible it is essential that the objects generated be known.

Given  $x$ ,  $y$ ,  $z$  as terms in any process our problem is to determine as far as is possible by a consideration of terms alone, how processes are differentiated when constants are substituted for variables. The first point that

claims attention is that any process yields to schematization in some form as in the case above, *i. e.*, any process has formal properties. If we substitute for the variables oxygen, nitrogen, and argon there results a process which is characterized as physical; if we substitute length, mass, and time we find processes which issue in the body of knowledge known as classical mechanics; if length, breadth and thickness constitute our constants, and these are defined in certain ways, we have processes which are geometrical. Suppose we substitute for one of our variables a "living organism." The processes which result become more complex—they may be either physical, biological, or psychological. If other "living organisms" are substituted for our other variables complexity increases, so that it is impossible to reach definite ideas by a consideration of constants alone. The belief that constants are the only method by which processes can be differentiated has led to much confusion. This much, it seems, we may say safely from a consideration of terms alone, that such words as "psychological," "perceptual," "physical," etc., are adjectival in nature, names in a qualitative sense which are applicable to processes which are in reality the noun. From this standpoint perception is adjectival, descriptive of terms, products, and relations in process. It can be shown, I believe, that this method is applicable to the whole region of psychology, *i. e.*, that "consciousness," the science of which the psychologist claims as his field, is not one of what I have spoken of as the "solid" portions of processes, but is an adjective descriptive of relations, terms, and products in processes.

It is not practicable further to attempt to differentiate processes from terms alone. Indeed, not a great deal can be accomplished by this method alone—by the method of examining the terms only. For example, it is not possible to define order by considering the set of terms to be

ordered, for any given set of terms have many orders. The notion of order must be derived from the relations that obtain among the members of the set of terms.

In the same manner it is not possible to exhaust the details of any process by an examination of the objects that enter into it. There are factors in the process which escape description on the traditional methods of reasoning which confine valid logical operations to the forms of syllogism.

The most fundamental relation involved in the perceptual process is that of asymmetry. This is a relation which implies diversity, yet all diversity does not imply an asymmetrical relation. For example,  $a$  is different from  $b$  and  $b$  is different from  $a$ , yet this is a symmetrical relation; but  $a$  can not be greater than  $b$  and  $b$  be greater than  $a$ . It is out of such a relation as asymmetry that series are generated, though not wholly. The terms in such a relational complex are different, and can never be identified, *i. e.*, rendered identical. A common predicate can never be applied in case one should desire to substitute for relational propositions the substance-attribute type, the type common in Aristotelian logic.

The perceptual process involves another kind of relation which has been called "aliorelative."<sup>3</sup> This means a relation such that no term has the relation in question to itself. The importance of these relational aspects will be indicated presently.

Of the perceptual process analyzed into terms and relations which are found therein, we may say of the latter, using such descriptive functions as are common to the logic of relations, that the *domain* of the relation is any other process; the *converse domain* is the original process which we have characterized as "perceptual"; and the

<sup>3</sup> Russell, Bertrand, *Introduction to Mathematical Philosophy*, p. 32. See Chapters IV-VI for a brief treatment of relations.

*field* is both the domain and the converse domain, *i. e.*, all the subject matter of natural knowledge.

We may further say that the relational aspects of the perceptual process are one-many. This, however, is a weak differentia for all relations may be replaced by one-many relations. Such relations are descriptions, and it was with this fact in mind that the statement was made earlier that all processes could be described in terms of the same kind of terms. A term in such a complex in which the relation is, is described by the relation, *i. e.*, asylogistically and not by the possession of qualities of any kind, not by the subject-predicate relation. For example, the discoverer of the doctrine of general relativity is described by that relation, and no other term (individual) has precisely the relation, the *r* of *x*. The observer of this process (*this* meaning any process) is likewise described by the relation. But there may be *many* observers of this process, it may be said. Everyday language permits such statements but they are vague. The "many observers of the process" yield to *a, b, c, d*, each of which defined by the relation *r* to *w, x, y, z*.

One of Eddington's dramatic examples<sup>4</sup> will illustrate the meaning here. The aviator who is moving past us at the rate of 161,000 miles a second believes that our cigar which we light at the same instant he lights his, lasts twice as long as his own; and we believe his lasts twice as long as ours. This is the case because he, in uniform rectilinear motion, believes himself at rest and that we on the earth are passing him at this great speed, while we on earth consider ourselves at rest. The perceptual process here may be analyzed into at least two terms (there may be any number) and the relation "observer." (We make the process as simple as possible for the purpose of the example.) Then each term which may be substituted for the

<sup>4</sup> Eddington, A. S., *Space, Time, and Gravitation*, p. 23.

first variable in the proposition  $xry$  is defined by the relation in question. It is some notion of perception very like this which is adequate for a relativistic physics.

Let us develop briefly the fact that the perceptual process involves an asymmetrical relation. Since such relations imply diversity all doctrines of "the self-identity of subject and object" become meaningless. The reduction of one of the terms in such a relational complex to the other is an impossibility. Such statements, therefore, as "Everything is mental," or "Everything is physical," "All is God, the Absolute," convey no information concerning anything in particular.

If  $a$  is the father of  $b$  it is not possible to reduce  $b$  to  $a$ . It may be that  $b$  is the father of  $c$  but he can not be the father of  $a$ . Again, if  $a$  is the observer of the process  $b$ , then  $b$  can not be the observer of  $a$ . This statement may be doubted in such a case as the following:  $a$  may be the observer of  $b$  and  $b$  may be the observer of  $a$  when both  $a$  and  $b$  are supplied with reaction machines, such as a nervous system. This difficulty is apparent when it is recognized that we are dealing with more than one process. Then, there is this significant difference that in the relation expressed in " $x$  is the father of  $y$ " there is what we may call a "necessary" element which is lacking in the other case. In both cases, properly interpreted, the relation is asymmetrical.

That the perceptual process involves a kind of relation which is termed *aliorelative*, i. e., one such that no term has that relation to itself, is a fact which should drive a great deal of mysticism out of philosophy. Monisms of various kinds would doubtless profit from a consideration of these relations. From the standpoint of perception this relation is significant in that it points to the fact that it is impossible to equate the "knower" and the "known" (to use common terms that should be avoided). Since asymmetri-

cal relations are always aliorelative, what has been said under that heading need not be repeated. The point is that both relations imply diversity.

Processes involve products. There is always something produced, the minimum being the ideal course which is carved out by the process in its actual going-on; the maximum, the elaborate institutions of science, religion, politics, and philosophy.

A scientific psychology, *i. e.*, a quantitative psychology, has as yet not been completely developed. We are at about the same stage in its development as were the Pythagoreans in the development of numbers. Hence, the difficulty in speaking, from the standpoint of current psychology, with any degree of certainty concerning products which result from perceptual processes. Psychology has not developed a "fundamental" operation, and it knows no "operator" which can generate a set or a group. It speaks of sets and groups, but in the vague language of a science looking for a technique. True, it possesses "sensations" and speaks of other processes in their terms, but it has never been able to tell how other processes issue from them. The conic sections, for example, are produced from the circle by a single operation, but the psychologist has been unable thus far to formulate a statement of a process that results in any analogous set. Psychology has not as yet produced its Sophus Lie.

There may be a reason for this state of affairs, and that reason can not be that the psychologist has not had time to do this work, for "the science of the soul" is pretty old. It may be that he has been too busy investigating the "soul" and the "mind" and has let processes alone.

If such be the case any process *becomes* perceptual when the proper terms and relations are present. Perception, then, is not an "awareness," not something "present to mind, plus meaning," not "the consciousness of

something present to sense," but rather the name of a process involving a peculiar kind of term, a kind that possesses some form of reaction system, and a peculiar kind of relation, namely, asymmetrical and aliorelative. The products that result is a psychology in the sense of that term suggested above in the notion of "consciousness," best expressed today by the term "behavior" though not completely; and the vague region expressed by some such term as "nature" or "natural knowledge" which becomes possible through, and takes its origin from, the perceptual process.

The "facts" of perception must be interpreted in the light of the analysis made above. These facts are such as the perceiver or knower, the object known, the stimulus, the perceiving experience, perceptual errors, and illusions.

The first two of these facts have been shown to be terms in a complex. Difficulties have arisen by an emphasis on terms only, such as lead to subjectivism or materialism. The application of the logic of classes to material that is not exhausted by such an operation leaves a foggy view. These terms are related in a manner which is described as asymmetrical and aliorelative. From such a characterization consequences flow which render some views of the nature of objects and perceiver, which have held prominent places in philosophic literature, meaningless.

A misinterpretation of the nature of perception has led to many strange views concerning the stimulus. The chief of these is the Kantian notion of the "thing-in-itself."<sup>5</sup> Many of the doctrines that advocate an "unknowable" are bound up with a theory of perception in which is involved in some inexplicable manner the "mind." The stimulus, so it is said, sets in operation a mind, and there result objects of perception and knowledge. The object is cre-

<sup>5</sup> The "thing-in-itself" of philosophy when translated to physics becomes the "matter" of that science.

ated by the machinery of the mind, and the mind knows its own children. An erroneous view of the stimulus has led to the doctrine that knowledge is a copy of the object, and more indirectly, to the doctrine of primary and secondary qualities.

The stimulus in a perceptual process is not something that awakens a passive mind which in turn stamps its categories on the raw stuff of the senses, but is a term in a complex. However far it may be traced back it can always be described in this manner. Certain wave lengths in certain relations generate sound; others generate light. It is difficult to state this clearly due to our habits of thought about such matters. What is defined as a stimulus in one complex or process may be an object or term in another of a different kind. But in all processes involving what we call a stimulus this same stimulus becomes an object in a further perceptual process. That is to say, the stimulus in one of its chief rôles, if not the only one it takes, is what the psychologist speaks of as the "object of perception." Whatever can be treated as a stimulus is capable of treatment as an object in the perceptual process. It takes the same place in the world of nature that any other natural event takes, and instead of being the "unknown cause" of anything whatever, it submits to precisely the same treatment that any natural event takes.

It has been pointed out that there is a process which is "subjective" in nature, and which may be shown by some such diagram as the following: Object——Perceiver. Between the two there is a process of perceiving which is psychological, something "going on in my head." Let us assume that there is such a process which can be stated in some manner such as " $x$  is seeing a tree" when  $x$  is not the seeing nor is the tree the seeing. How can a theory of perception as a process absorb such a fact? If the fact is capable of description it takes its place along with any



other of the same kind. That is, it is analogous to the fact that  $x$  is hitting a nail or the wind is blowing the leaves. When  $x$  describes the experience (process). " $x$  is seeing a tree" he will proceed along the same lines as when  $z$  describes the experience of " $x$  seeing a tree." If his description is adequate he will state the terms and relations in the process, for any fact that can be described must be described in the language that gives origin to the logic of classes and of relations, and in no other way.

It has been frequently argued that description of a process is fatal to the process, that science falsifies reality, that analysis gives only static views of processes which are *the* real. Touching our problem of perception it is said that description of it, or of any other "psychical" experience for that matter, falsifies the experience. The description of " $x$  has the toothache" is different from " $x$  has the toothache"—the immediate experience. But the description of " $x$  has the toothache" differs in no essential respect from that of any process in which a constant is substituted for the subject and the predicate respectively of the original proposition. A "psychical" experience is no more falsified by description than any other experience (process). That is to say, there is nothing peculiar to "psychical" experiences which renders a description of them false when description may be true of some other process, such as the falling of a tree. Of course, this does not show that description does not falsify processes, but it indicates that if it falsifies "psychical" processes it also does it to "physical" processes.

We can not here attempt to answer the arguments of the falsifactory nature of description and analysis, but wish to say that there is no legitimate sense in which we may live in a world of "description" and one of "appreciation." The world of "appreciation" may be a little more difficult in yielding to our methods of treatment, but when it does

yield as parts have done from time to time, a new science is born. Indeed, the history of science is the story of how matters of "appreciation" have yielded to description and of how the technique of description has been refined.

Such beliefs (that science falsifies reality) are seen to be unwarranted in view of the fact that what science has to say about an event, process, or object is precisely what the event, process, or object is. If a mistake has been made it is always corrected in terms of another descriptive process, and not along lines which abandon description, unless we become mystics.

Errors and illusions have always been stumbling blocks to otherwise neat and attractive theories. They are usually believed to be "mental"—in some way the "mind distorts the real." It is strange, as has been pointed out by others, that a great many mechanical devices, such as the thermometer and the camera, have this uncanny habit along with the mind. Would it not be better, in all such cases of "distortion," to regard them as brought about by the interaction of various physical things? Every case can be described, and becomes, therefore, a part of the furniture of nature.

The belief that there is a unique *real* object or process, described by a few simple terms and relations has caused much difficulty in dealing with perceptual errors. Just as no set of terms has one order but as many as it is capable of, so is an object (any unit of discourse) not a unique something but everything it is capable of. Almost every day objects (in the sense above) are taking on complexity; new "orders," so to speak, are discovered, and the object is all the "orders" it is capable of. It seems to me that a

thorough recognition of this point will answer the difficulties of variability in perceptual experiences. Error, interpreted in the perceptual sense, is answered in the same manner. Interpreted as "falsehood" as against "truth," questions arise which are not within the province of an outline of a theory of perception.

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